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Message from the Editor

Why measure the weight of a colonial coin? In this issue, Dr. Charles Smith provides a tutorial on the types of information that can be obtained from weighing a coin and guidelines for obtaining a valid weight comparison analysis for a population of several coins. In addition, he discusses weight loss due to circulation wear and chemical reactions on the coin's surface. Interestingly, he also mentions another wear factor called peening that lowers the grade of a coin without loss in weight. Finally, in the appendix, the basic types of weight distributions are discussed along with example charts.

Reported in this issue are the discoveries of two previously unknown colonial coins. The first is a fascinating Massachusetts silver overstrike while the second is a new colonial coin type. The Massachusetts silver overstrike features a Willow Tree shilling struck over a New England shilling. It is the only known specimen of one Massachusetts silver type overstruck on a different Massachusetts silver type. To make the coin even more amazing, the reverse dies of both the host and the overstrike coins are new. It seems only appropriate that this important specimen was discovered during the 350th anniversary year of the founding of the Boston Mint.

The new colonial coin type is a mule, combining a Georgivs Triumpho obverse with a 1767 Danish West Indies XXIIII skilling reverse. The authors write that: "The Georgivs Triumpho token, in and of itself, has long been regarded as of American relevance; moreover, since the Danish West Indies are now the U. S. Virgin Islands, the colonial relevance to U. S. collectors is in some sense doubled." Currently, two specimens are known, both with extensive circulation wear. There is no evidence that these specimens were silvered, so they probably passed as coppers valued at an English halfpenny.

Both of our associate editors, Michael Hodder and Louis Jordan, have made significant contributions in commemoration of the opening of the Boston Mint 350 years ago. Michael wrote the catalogue for the Massachusetts silver coins from the Hain collection that were auctioned by Stack's early this year. The catalogue is a masterpiece and is sure to be highly valued by collectors for years to come. It includes high quality images along with excellent technical descriptions of most of the known varieties of the coins produced by the mint over a 30 year period starting in 1652.

As announced in our previous issue, Lou has written a book on the operations of the Boston Mint. His in-depth study is based on information that he gleaned from an extant ledger of mint-master John Hull and also his study of the political and economic factors that influenced the operation of the mint. The book, titled *John Hull, the Mint and the Economics of Massachusetts Coinage*, will be published by C4 (Colonial Coin Collectors Club) and distributed by the University Press of New England. It will be a large format book with imprinted hardcover and dust jacket. The dust jacket is being designed by award winning designer Dean Bornstein. The book is xx+338 pages with 55 illustrations, two appendices and an index. The price is $50 per copy. For puchasing information, please contact the president of C4, Ray Williams, 924 Norway Ave., Trenton, NJ 08629. His e-mail address is njraywms@optonline.net and his telephone number is (609)587-5929.

A *CNL* Internet web page has been created and is posted on the ANS website. I encourage everyone to visit this page which is located at www.amnumsoc.org/cnl/. You will find a brief description of *CNL*, a subscription form, sample articles from recent issues and a new on-line cumulative index.

The *CNL* subscription form, which was recently created, is available for download in both MS Word and Acrobat (PDF) formats. Also, three

sample articles are provided in Acrobat format. These articles were selected to demonstrate the wide range of material that is published in *CNL*. No matter if you are a collector of early American coins, a numismatist specializing in early American coinage or a historian focusing on early America, you will find something of interest in *CNL*.

The cumulative index is a detailed resource that covers the entire publication period (42 years) of *CNL*. It is broken into three sections: subject and author, illustrations, and a page/issue number conversion chart. The on-line index is searchable via your software FIND command and, importantly, it will be updated after each new *CNL* issue is published. The on-line index replaces the old hard copy index that had been published at random intervals. The format of the on-line index is the same as that created by Jim Spilman, our Editor Emeritus, and distributed with CNL-113. We owe Jim a big thank you for all the hard work he put into creating the *CNL* index.

Interest in colonial coins is at an all-time high. New and important discoveries, such as reported in this issue, are still being made in this area of numismatics. But there are still many mysteries to be solved, so stay tuned to *CNL* as we search through the mists of time for the answers.

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WEIGHT ANALYSIS, WEIGHT LOSS, WEAR, POROSITY AND GRADE IN COPPER COINAGE

by
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PART I: THE BASIC ISSUES

I. INTRODUCTION

One of the easiest measurements to make on a coin is that of weight. It is a simple matter to place the coin on a calibrated scale of sufficient sensitivity and to read the indicated number. No serious preparation of the coin is necessary prior to measurement and no calculations or other numerical manipulations are required after the measurement. Therefore, it is not surprising to find weight values listed in modern auction catalogues, as part of a coin's description. We also commonly read, in numismatic reference books, about weight ranges for coin populations. But why this emphasis on weight ... is it just because it is a relatively easy measurement to make? What can we discover by weighing a coin and what are the limitations and pitfalls?

The purpose of this article is to examine the types of information that can be obtained from coin weight measurements and to suggest some practical guidelines for carrying out coin weight analysis studies. The discussion will focus on copper coinage of the late 17th, 18th and early 19th centuries, both struck and cast. The information presented in the sections that follow emphasizes two themes: 1) how to make good single specimen measurements, even for problem coins and 2) how to make a valid weight comparison analysis for a population of several coins.

II. WHY MEASURE WEIGHT?

There are at least two important reasons to make an accurate measurement of the weight of a coin: 1) the weight of a coin is part of the identity of the coin and 2) once known, its weight can be compared to the weight values of other coins of its type, as part of a weight analysis study.

Obverse and reverse die types, weight, diameter, error type (if any), state of preservation and planchet composition make up a coin's identity. Measurement of weight, diameter and composition require scientific instruments, the latter measurement being more complicated and expensive. However, the look of a coin and its weight go a long way in characterizing its individuality and establishing its authenticity.

Weight analysis studies address coin production issues. That type of study is discussed in detail in Section V but the central concept is simply to compare the distribution of weight values of a sample of coins of the same type, either within the sample itself, or to another sample of coins that may in some way be linked to it. In fact, it is often the inverse problem we are interested in; namely, what are the circumstances that explain the oddities in the weight profile, rather than knowing these circumstances and predicting the resulting weight profile. Case studies of weight analysis for Connecticut coppers and the contemporary counterfeit English George III halfpenny series will be given in Section V.

III. HOW TO MEASURE WEIGHT

For copper coins of the era discussed in this article, it is common practice to report weight in the units of grains [1.000 grains (gr.) = 0.0648 grams (g.) or 10.00 grams = 154.3 grains] and to a precision of one tenth of a grain. Since a typical States copper weighs around 150 grains, this is indeed a high precision measurement, i.e. one part in 1,500. To go one decimal place higher in precision is not warranted in most studies and becomes a serious metrology challenge. To go to one part in 15,000, room drafts and building vibrations must be controlled, humidity effects can be detected and coin preparation (for example, removal of microscopic loose material within the coin's devices and lettering) may be necessary. Thus for practical reasons a precision of 0.1 grain is usually employed.

Assuming one has access to a weight scale of 0.1 grain precision, the question of accuracy now becomes important. Accuracy deals with calibrating the scale using a known standard weight so that it reads the "right value." Each type of scale has an adjustment device for calibration and fortunately it is not difficult to find sources of standard weights to use to check the scale. A visit to your local high school, college or university may yield a standard weight that can be borrowed or the address of a scientific supply company from which such a standard can be purchased. As an alternative, perhaps the school would allow you to weigh a coin, say a U. S. quarter, on their calibrated scale. Then that coin becomes a weight of known value and can be used to adjust your scale to read its value and to check, now and then, to see if the scale requires further adjustment. If purchasing or borrowing a standard weight, a good choice would be a 10.00 gram weight, since it would nominally be about the same weight as a halfpenny or States copper.

Finally, the calibrated scale should be used on a level and stable surface. Electronic scales usually require a modest warm-up period, perhaps 15 minutes or more. The goal here is to assure precision (that is, a measurement reproducible upon repetition) and accuracy (that is, the correct indicated value). It is only from measurements that are precise and accurate that we can extract useful information.

IV. WEIGHT LOSS: WEAR AND POROSITY

Two hundred year old copper coinage can be found in a spectacularly broad range of preservation; from worn smooth to sharp with detail and from porous and black to red-brown and lustrous. The primary reasons for this broad condition range are that copper is both relatively soft and somewhat chemically reactive. Thus the state of preservation of a coin can be thought of as the integrated effects of its entire physical and chemical history, from its time of production to its current local situation. Most chemical and physical changes to a coin are irreversible and most tend to reduce the weight of the coin from the value it had when struck. In this section we discuss the two most frequently encountered weight loss effects for copper coins, wear and porosity.

A. WEAR

In circulation, a coin is acted upon through physical contact with its environment. This often results in the removal of metal from the higher areas and rims of the coin, thus reducing its weight. We call this process wear. Wear results in loss of detail and thus reduced eye-appeal and technical grade. Therefore, when comparing the weights of two coins we must keep in mind that we are comparing their <u>current weights</u> and not their as-struck weights. This issue becomes a serious concern in weight analysis studies. We will have more to say about this subject in Section V.

In order to get a quantitative measure of weight loss by wear for copper coins, the following experiment was carried out. I borrowed 5000 Lincoln Cents from a local coin shop.[1] I sorted them by date into two groups: pre-1942 and post-1942. I retained the former group and rejected the latter group, since in 1943 zinc-coated steel was used and for at least three years after that date, cartridge brass was incorporated into the planchet stock. The composition of the Lincoln Cent was again changed in 1959 and in 1982. Next, using *The Official American Numismatic Association Grading Standards for United States Coins* (compiled by Ken Bressett and A. Kosoff, Western Publishing Co.) I graded hundreds of pre-1942 cents until I had fifty clean and undamaged examples in each of the following grade categories: About Good, Good, Very Good, Fine, Very Fine and Extremely Fine. Each of the six grade groups of fifty coins were then weighed. A group of twenty-five coins grading About Uncirculated was used to establish the "as-struck" weight for the experiment. Average weight loss by grade was determined for each of the six grades. The results are shown in Table 1.

Table 1. Weight Loss by Grade for Copper Lincoln Cents Dated 1909 - 1942

ANA GRADE	WEIGHT LOSS IN PERCENT
Extremely Fine	0.12
Very Fine	0.31
Fine	0.49
Very Good	1.07
Good	2.82
About Good	4.43

Standard Mint Weight: 3.11 grams or 47.99 grains

The point here is not to directly link weight loss to grade for Colonial and Confederation coppers, but to indicate that a well-worn but readable copper coin may have suffered a substantial weight loss from its as-struck weight.

At the grade level of About Good, a coin is still identifiable as to date and type. A second experiment was carried out to determine the minimum weight loss by wear at which a coin becomes unidentifiable. This limiting weight loss will of course be different for different coin types, depending upon the depth to which the dies were cut, the nature of the major devices and the size and style of the lettering, among other considerations. Nonetheless, in order to get a general impression of what this limit might be, the following procedure was used. I placed a group of fifty pre-1942 "valueless" but identifiable About Good Lincoln Cents into a rock tumbler (a rotating drum device used to polish small stones) along with five Jefferson Nickels in grade Fair, one penny-sized steel washer and five grams of playground sand. I slowly tumbled this combination (putting the coins "back into circulation" so to speak) looking in on the condition of the Lincoln Cents periodically, until the lettering had blended into the rims and the major devices had all but faded away. At this point I cleaned the Lincoln Cents in warm soapy water, dried them and weighed them. Their average weight loss from what they would have weighted at grade About Uncirculated was about twelve percent. I do not mean to say or even imply that this weight loss limit is typical for all copper coins. It is even an approximation for the Lincoln Cent since there is some margin of judgment in deciding just when a coin one is familiar with is actually unidentifiable. However, this experiment does serve to establish that when a copper coin is unidentifiable due to wear, it has probably lost at least 10% to 15% of its as-struck weight.

References are on page 2357.

The results of these two wear studies have several practical applications.

1. When comparing the weights of two copper coins, if their weights differ by only a few percent, their wear states should probably be considered. For example, if a particular coin is claimed to be the lightest known example of its type when compared to the next lightest example, wear must be taken into account to establish which coin was the lighter coin <u>at the time they were struck</u>.

2. When comparing a single coin to a group of coins of the same type, understanding where that coin fits within the variability of the group again must take wear into account if the variability of the group is narrow.

3. In cases where the weight distribution of a large group of coins of the same type is bimodal (see Section V), if the modal maxima are less than a few percent apart, weight loss by grade should probably be considered. If the modal maxima are several percent apart, other circumstances may pertain, i.e. variability in blank stock.

And finally,

4. In cases where the weight distribution of a large group of coins of the same type is skewed, i.e. the mean or average weight and the median weight are more than a few percent apart, again this may be entirely the result of weight loss by wear and the average grade of the lighter side of the distribution must be examined (again, discussed in Section V).

B. POROSITY

Through circulation and storage, including loss to burial, a coin is exposed to a range of chemical interactions. Chemical reactions on the surface of the coin can result in copper compounds that are water soluble and/or inadherent or soft, and weight loss will ultimately result. The effects of an acid environment, for example loss to burial in acidic soil, causes a condition known as porosity, giving the coin's surface a macroscopically granular texture. Porosity is usually accompanied by discoloration and, for copper coins, often a dark brown to near black non-reflective surface results. This color is a complex of oxides of copper and other copper compounds.

Because the entire surface of the coin is subject to these chemical reactions (the devices as well as the fields), as contrasted to wear which works most aggressively on the high areas of the devices, lettering and rims, porosity can result in considerable weight loss before the coin is rendered unidentifiable. Experiments with porosity formation are destined to be oversimplifications of the complex compound formation scenarios found in the real world. However, using an acid mixture of 0.10 molar hydrochloric acid and 0.10 molar sulfuric acid, a granular surface texture typical of a long buried copper coin can be produced with weight loss ranging from four to eight percent. Loss of identity as to die type occurs at about twelve to fifteen percent weight loss. Coins struck on cast planchets, as were the halfpennies of William III, and cast contemporary counterfeits of Queen Anne, George I, II and III, as well as cast counterfeits of States coppers may suffer even greater weight loss due to chemical reactions since fissures and cavities caused by supercooling from the melt at casting and the escape of gases, can lead chemical reactions deep into the bulk of the coin. These voids remain available over time as host locations for weight loss chemical activity.

PART II: CASE STUDIES

V. WEIGHT ANALYSIS STUDIES

In this section we discuss the three broad categories of weight analysis studies: 1) comparing one coin to another coin, 2) comparing one coin to a population of its peers and 3) comparing a population of several coins to another population of several coins of the same or different type.

1. Comparing one coin example to another coin example.

Let us revisit the topic discussed briefly in Section IV; namely, coin A is claimed to be the lightest example known of its type. Imagine now we discover a second very light weight example, coin B, but the weight of coin B is ever so slightly greater than the weight of coin A. When we weigh a coin we measure its current weight and not its weight at the time of production. And we know its current weight is a consequence of its history (wear and porosity) as well as the variability in the production technology when made. But what we would really like to discover is something about its production. The issue of production variability did not come up in our discussion of Lincoln Cents since weights of modern coinage by the U. S. Mint is controlled to better than a few parts in a thousand, or about 0.2%. However, production variability is a major issue for copper coinage of the 17th, 18th and early 19th centuries and is a worthy subject for study in and of itself. For example, in the 18th century the Tower Mint in the production of English George III halfpennies (1770 to 1775) adhered to a batch average of many coins. These halfpennies fell within a pre-specified weight range of 140.9 to 167.9 grains and in practice attained a nominal average weight of 153.4 grains. This represents an as-struck production variability of about 8.0%. This is before wear and porosity spread out the extant population spectrum to its current as-measured weight range today. In practice, the Tower Mint did a better job at quality control than these guidelines would imply. A group of thirty regal halfpennies dated 1770 to 1775, without regard to grade, was measured to have an average weight per coin of 151.20 grains with a standard deviation of 4.83 grains. In other words, two-thirds of the examples were within a range of ±4.83 grains or 6.4%.[2] Thus, simply ranking whether coin A or coin B has the lesser weight is a literal interpretation of the claim that coin A is the lightest known example, but this literal interpretation may not be numismatically very interesting. The issue of importance is whether their slight difference in weight has anything significant to say about their production.

Given these comments let us consider the case for which a specific coin type is found struck on two different batches of blanks, a heavier batch and a lighter batch. The draped bust left Connecticut coppers dated 1787 with crosses and small lettering in the legends are a case in point.[3] It could happen that the slightly heavier of the two examples (coin B in our discussion) is from the heavier batch of blanks but is the lightest known example representing that subgroup. That fact would be numismatically significant and far more important to establish than simply ranking coin B as the second lightest known example. Thus, the more one knows about a particular coin and the circumstances under which it was made, the more one can say about other coins of that type. A weight distribution for this group of Connecticut coppers is included in the Appendix as Figure 2. This brings us to the second category of weight analysis.

2. Comparing one coin to a population of several coins of the same type.

This second weight analysis category is often crucial in the practical context of determining the authenticity of a coin that is suspect as counterfeit. We must keep in mind that counterfeit coins can have very convincing, indeed genuine, wear and porosity. Sometimes the extent of the coin's degraded condition renders device detail and lettering detail less than diagnostically definitive.

The Appendix starts on page 2354.

Here a weight comparison (assuming the coin diameter and/or thickness is not significantly out of the range expected for its type) is the next logical step in establishing or refuting authenticity. Reasonable consideration of wear and porosity must be made but the essential task is to find a large population of similar coins with which to compare the weight of the suspect example. Exemplar weight distributions for some of the States copper coinage and for English George II and George III halfpennies and Irish George II and George III halfpennies (both Regal and counterfeit) can be found within the references listed at the end of this paper. The issue I want to expand upon is how to make the actual comparison.

Let us take another 18th century example. Assume we have an English 1770 George III halfpenny and we suspect it may be counterfeit. (1770 is in fact the most scarcest date for counterfeit George III halfpennies, having the regal date range 1770 - 1775 and it would be interesting to find a counterfeit example with that date.) The devices look "OK" although the assumed coin in question is in grade fine and slightly porous from being in the ground, thus making comparison of details difficult. The diameter is within the expected range of 28.5 mm to 30.0 mm and we measure its weight to be 162.0 grains. We know that a weight analysis of the regal population for this coin type has been published[4] and we read that the royal mint specified production weight range is from 140.9 to 167.9 grains and the average typical measured weight for a coin of this type is 151.20 grains with a standard deviation of 4.83 grains. Thus the suspect coin is within the mint weight range. But now what?

Without going into a lesson in mathematics (for details, see Statistics in an encyclopedia or on the web), for a normal population distribution (a "bell-shaped curve") 68.3% of the examples lie within one standard deviation (plus or minus from the mean) and 95.5% of the examples lie within two standard deviations. The weight of the coin in question lies <u>more than</u> two standard deviations from the mean (152.0 + 4.83 + 4.83 = 160.86 as compared to the coin's weight of 162.0). We further note that it is worn (grade fine) and slightly porous and we recall that both processes, wear and porosity, result in weight loss. Thus this coin weighed <u>even more</u> than 162.0 grains at the time it was produced. It is more likely than not (simply based on the probabilities) that it is counterfeit. What next?

Since the suspect example is not a coin of high enough collector value to warrant the expense of an elemental composition analysis, two further observations should be made. Because it is "overweight" it could be made from an alloy of copper, perhaps a lead-bronze. Thus a specific gravity measurement could determine if its specific gravity is greater than that of copper at 8.72. A second line of inquiry is to examine the coin for indications that it has been produced by casting.[5] Casting from molds made from a regal 1770 halfpenny would transfer all the correct device features and assuming reasonable circulation and environment impact, can result in a grade fine example with genuine wear and with genuine porosity. Under low magnification (about 5X), the surface should be checked for pock marks. Porosity tends to produce granulation that appears "above the surface" while casting produces small gas bubbles which results in pitting or pock marks which are "below the surface." Furthermore, under magnification, the rim of the coin may show file marks where the sprue from the casting process has been removed and the rim "dressed" with a file or stone. Thus one builds a case for authenticity, or lack of it, based upon several observations and measurements. Weight analysis is an important starting point.

And finally,

3. Comparing one population of several coins to another population of several coins.

In comparing large numbers of coins, one again depends on statistical measurements. To compare one population of coins, say group A, to another population of coins, group B, we

compare the mean value and standard deviation of group A to the mean value and standard deviation of group B. To be a valid comparison, the coin groups must be, to a reasonable approximation, normally distributed about the mean value, i.e., have a "bell-shaped" distribution. Thus, one compares the "typical" weight of population A (the mean value) to the "typical" weight of population B and the "spread" of population A (the standard deviation) to the "spread" of population B.

As simple as this sounds, there are cases for which one needs to verify that the populations are <u>fair</u> to compare. Let us assume one is comparing two populations of FUGIO coppers; one is a hoard of 75 coins and the other is a large museum collection of 350 coins. If the hoard population contains a certain ratio of club ray examples to pointed ray examples, a subgroup of 75 examples from the large museum collection should be formed (selected by random draw) to make up a fair sample population of 75 coins with the same ratio of club ray examples to pointed ray examples as the hoard. This "leveling of the playing field" process helps assure one does not have a biased population in one case with respect to the other case. One then compares the two "fair" and same-size populations. A "new" fair subgroup of 75 coins drawn from the museum collection can be formed a second or third time to assure the robustness of the comparison.

And as our last example, we will discuss the comparison of two populations, one of which is skewed, that is, one population is bell-shaped but the other has significantly more examples to the one side of its mean value than the other. Let us assume we wish to compare the weights of a population of 200 examples of Connecticut coppers dated 1785 to a population of 200 examples of Connecticut coppers dated 1788. The working hypothesis being that the examples dated 1788 will be lightweight since all Connecticut coppers dated 1788 are "counterfeit" in the sense that no official government authorized mint was empowered to produce Connecticut coppers dated 1788.[6] However, when we weigh the 200 examples dated 1788, we discover that although the average weight is in fact less than the average weight of the 1785 population, the population dated 1788 is significantly skewed to the lightweight side of its distribution, that is, there are more coins to the lightweight side of the mean weight than to the heavyweight side. This circumstance could spoil (bias) the comparison. A quick look at the 1788 group reveals a possible reason the population is skewed ... the population contains many examples in lower grades. How does one proceed to check the hypothesis since we are faced with what appears to be an unfair comparison? The procedure we can use here is similar to the previous case study. We pick from each population a subgroup (known as a statistical sample*) but this time our purpose is to level the playing field by grade, where before it was to level the playing field by die type (club rays to pointed rays). Starting with the high grades, one selects, by pairs, an example from each population. Perhaps from each population we can find 2 AU examples, 8 EF examples, 15 VF examples, 20 F examples, 30 VG examples and 40 G examples and, at this point, we run out of possible pairings. We now have two equal size subgroups of 115 coins, each of which are grade (and, hopefully, wear/porosity) fair. We now compare the mean weights, the standard deviations and the shape of the weight distributions. If the 1788 sample is still skewed and its average weight less than the average weight of the 1785 sample, we now have good reason to suspect the makers of the 1788 Connecticut coppers were intentionally producing light weight coins!

Has the above weight analysis study ever been done? Not to the author's knowledge, but anyone reading this article could do it, even if you don't have any coins, you don't have a calibrated sensitive weight scale and even if you don't know how to grade Connecticut coppers. How? By using the data from modern auction catalogues that feature graded and weighed examples of

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* Just as in a political opinion poll, the polling company does not ask everyone in the United States each question, but only a representative sub-group of the population, i.e., a statistical sample.

Connecticut coppers. Carry out the pairings by grade within each catalogue, to level the playing field with respect to weight loss by wear/porosity and to compensate for grading variation by each cataloger, until you have a significantly large sample population, say 100 "coins" of each date. List the weights for each population and do the calculations for average weight and standard deviation. Did the counterfeiters of 1788 Connecticut coppers cheat on weight? To measure is to know!

VI. CONCLUDING REMARKS

It is not difficult to make accurate and precise weight measurements to 0.1 grain in 150 grains. This degree of precision will permit several interesting weight analysis studies to be made on copper coins, specifically the Colonial and Confederation coppers circulating in British North America as well as the regal and counterfeit halfpennies of England and Ireland circulating contemporary with them. Several hypothetical case studies were discussed. In comparing populations of several examples, it is important to account for possible bias in the populations.

Several experiments with Lincoln Cents provide an intuitive impression for weight loss in copper coinage caused by wear and porosity. These numerical values are specific to Lincoln Cents and should not be carried over numerically to any other coin series.

Finally, it is the opinion of the author that "weight corrections" to individual coins are always problematical and cannot be done reliably with our current understanding of the complex issues involved.

END NOTES

I. PEENING

We have discussed weight loss from wear and porosity and its correlation with grade. There is a third process that results in decreasing the grade of a coin, but interestingly, involves essentially no loss in weight. This process is called peening. A coin in circulation suffers very frequent small (and sometimes not so small) impacts. This relentless "hammering" blunts the details of the devices and lettering, not by removing material but by pushing the higher relief structures into the lower relief structures. It is hard to say which of the three processes, wear, porosity or peening, has the greatest degrading effect. For a coin in normal circulation, wear and peening probably dominate over porosity, but once a coin is lost to burial, porosity plays the dominant role.

II. WEIGHT LOSS AND GRADE IN U. S. LARGE CENTS

A manuscript of a paper by Damon Douglas, entitled "The Copper Coins of New Jersey," includes a brief discussion of wear (grade) and weight loss for U. S. Large Cents. He measured the weights of 130 coins, dividing them into seven grade groups. The table, reproduced below through the kind permission of the American Numismatic Society, is titled "Table of Weight Adjustments for Wear" and lists his results (from the manuscript, page 79). I have added a third column expressing Mr. Douglas's results in percent weight change, in order to facilitate comparison to TABLE 1 for Lincoln Cents. I have also listed the Standard Mint Weight for U. S. Large Cents below the table.

Table of Weight Adjustment For Wear

CONDITION	WEIGHT TO BE ADDED (Grains)	PERCENT WEIGHT CHANGE
UNC	0	0
XF	1	0.59
VF	2	1.19
F	4	2.38
VG	6	3.57
G	8	4.76
FAIR	11	6.55
POOR	15	8.93

Standard Mint Weight: 10.89 grams or 168.0 grains

It should be noted that the percentage weight changes with grade for the Large Cents are about twice that for the Lincoln Cents. Although this may be due somewhat to the subjective nature of grading a large coin as compared to grading a smaller coin, it is more likely related to the fact that the devices and, especially, the thick lettering and complex rims of the Large Cents incorporate a greater percentage of metal than does the Lincoln Cent design. It is this material that must be removed by wear to effect a grade change.

III. QUALITATIVE VERSUS QUANTITATIVE

Again, we are reminded that the quantitative studies of weight loss reported in this paper pertain specifically and only to the two coin types measured, namely Lincoln Cents and U. S. Large Cents. The copper coins of the 17th, 18th and early 19th century reflect far more variability in their production technologies. This is especially the case for blank production where type (cast or rolled sheet), size and composition must be considered, as well as the depth to which dies were cut and the pressure capabilities of various types of coin presses. However, the qualitative correlation of grade with weight loss is strong and applies, in general, to all coinage types and its detailed understanding is interesting and important to numismatic metrology.

APPENDIX

THREE WEIGHT DISTRIBUTION EXAMPLES

The basic types of weight distributions, normal, bimodal and skewed, discussed in Part II, are illustrated below. The distributions are redrawn from Mossman,[7] CHARTS 8, 20 and 13, respectively.

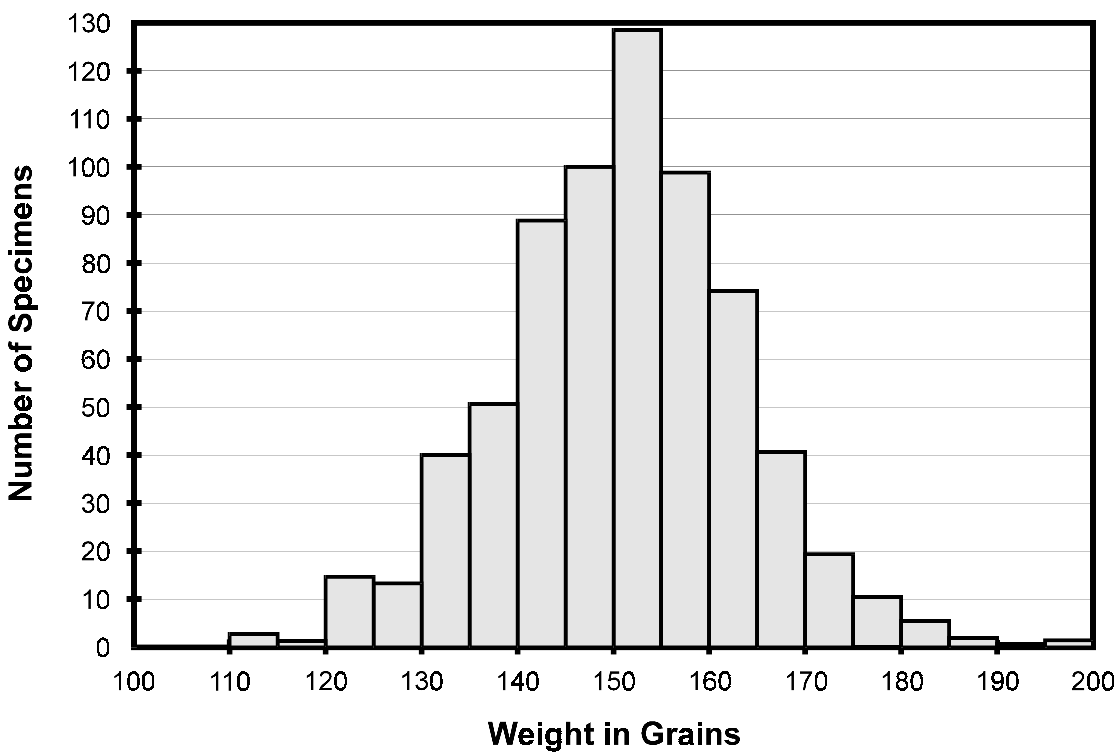

Figure 1. An example of a normal or "bell-shaped" weight distribution for a group of 675 Fugio coppers with pointed rays. Mean weight 150.0 ± 12.6 grains. *Data for Figure 1 courtesy The Colonial Newsletter Foundation.*

Figure 1 shows a good example of a normal or "bell-shaped" weight distribution for 675 Fugio coppers with pointed rays. The mean weight of the group is 150.0 grains with a standard deviation of 12.6 grains. The distribution is presented as a histogram. One can think of this histogram as consisting of stacks of coins in weight ranges plus and minus 5.0 grains from the mean value. The center stack, spanning from 150.0 to 155.0 grains contains 128 coins. The stack to the left of center spans 145.0 to 150.0 grains and has 100 coins, while the stack to the right of center spans 155.0 to 160.0 grains and contains 98 coins, etc. Distributions of this form are said to be symmetric about the mean.

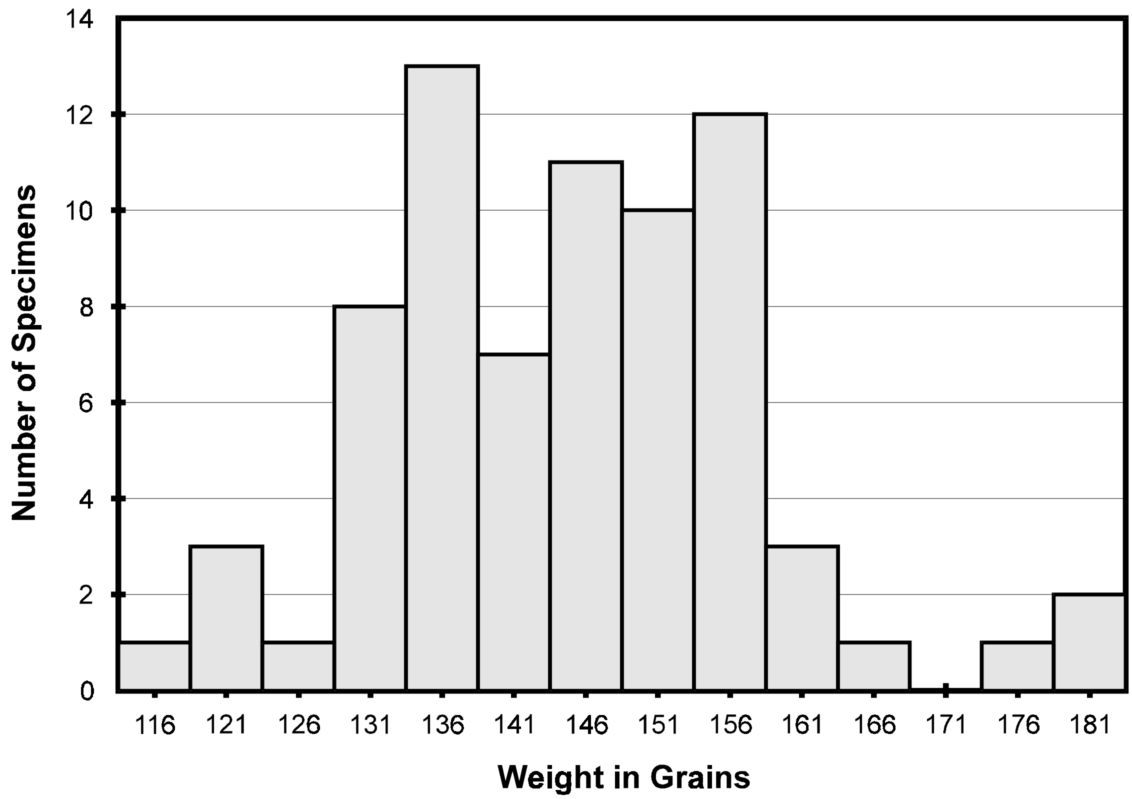

Figure 2. An example of a bimodal weight distribution for a group of 73 draped bust left Connecticut coppers dated 1787, having crosses and small lettering in the legends on both sides. Mean weight 145.0 ± 12.7 grains.

Figure 2 shows the weight distribution for 73 draped bust left Connecticut coppers dated 1787, having crosses and small lettering in the legends on both sides. These Jarvis and Company varieties are not a homogeneous population and the bimodal weight distribution suggests two different batches of coin blanks were employed in their production. With the two "peaks" only 15.0 to 20.0 grains apart, the weight difference between the two groups is the result of a thickness and/or diameter difference and would probably not be noticeable to the eye.

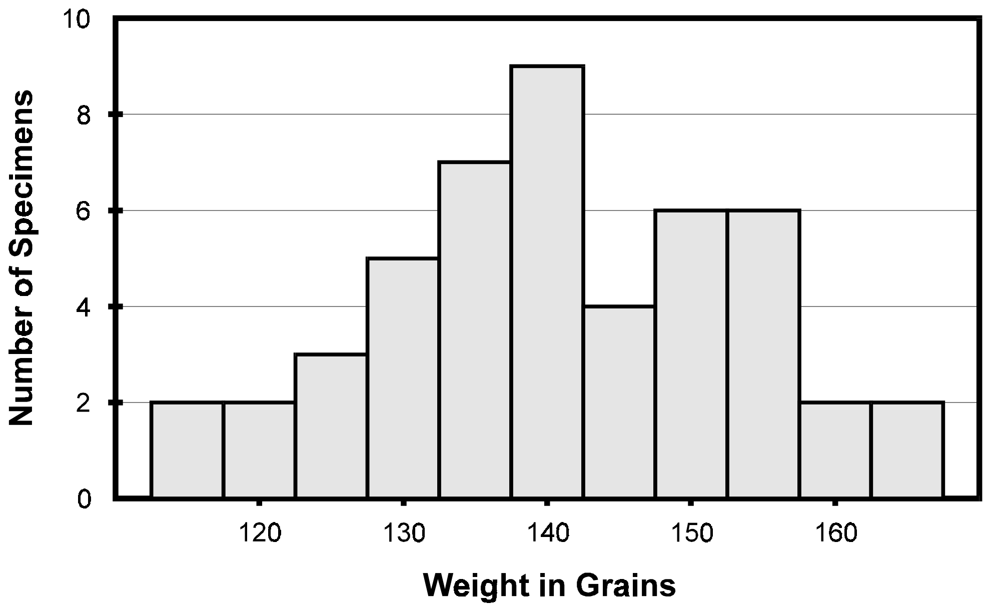

Figure 3. An example of a skewed or unsymmetric weight distribution for a group of 48 coulterless plow New Jersey coppers dated 1786. Mean weight 143.0 ± 12.5 grains.

Figure 3 shows the weight distribution for 48 coulterless plow New Jersey coppers dated 1786. The mean weight for this group is 143.0 grains with a standard deviation of 12.5 grains. The mean weight falls more or less at the notch in the distribution. The distribution is skewed to the light side of the mean with about 28 examples to the left of the notch and about half that many, 16, to the right. To quantitatively measure the extent of this "lopsidedness" in the distribution (the second moment of the distribution) with statistical confidence, one would have to assemble a population about three times the size of the one shown in Figure 3. However, the unsymmetric look of this distribution is clearly suggested with only 48 coins in the sample.

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Discovered: A 1652 Willow Tree Shilling Overstruck on a New England Shilling

by
Michael Hodder; Wolfeboro, NH

(TN-187)

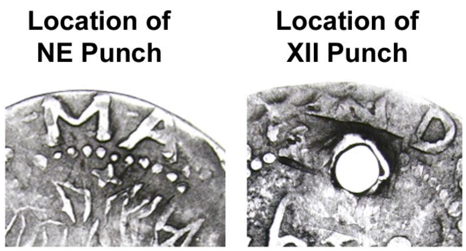
New Noe 3-F Willow Tree Shilling overstruck on a new Noe I-E New England Shilling (Shown 2X actual size.)

Photo courtesy The New-York Historical Society.
Photographer: Gina Fuentes Walker

An important Massachusetts silver coin has been discovered. In terms of numismatic rarity it is unique and is currently the only known Massachusetts silver type overstruck on a different Massachusetts type. The reverse dies of both the host and overstrike coins are also new, both being unlisted in Sidney Noe's standard catalogue of the series. The coin's existence strongly suggests that Willow Tree coins were struck immediately after New England type coins, something numismatists had previously accepted on the basis of logical reasoning.

At first glance, the coin appears to be a Willow Tree Shilling with a hole in it. Its physical condition, even holed, marks it as one of the most sharply struck Willow Tree Shillings known, with complete legends, full tree, and a complete date and denomination. Closer inspection of the coin, however reveals that the Willow Tree type was struck over another coin. This, by itself, is a surprising observation, since the only other Massachusetts silver coins known struck over hosts are the Oak Tree Sixpences struck over Oak Tree Shillings. No Willow Tree coin has ever been seen before that was struck over a host coin. Close inspection reveals that the undertype is a New England Shilling. No other cross type overstrike is known in the entire Massachusetts silver series.

Attributing the Willow Tree obverse and reverse dies is easy because the coin was so sharply struck and so much detail can be seen. The obverse die is clearly that of Noe 3. The reverse, however, is a new die, one not seen on any other Willow Tree Shilling. Noe's reverse C comes closest to the new die, but the positions and shapes of some of the letters and the sizes and shapes



Detail showing the location of the undertype's punches.

of the date numerals rule out C as a candidate and confirm the uniqueness of the new reverse die.

The New England undertype punches are clear enough to allow them to be attributed, as well. In the illustration that accompanies this technical note, one can see the clear remnants of the NE punch at the top of the Willow Tree Shilling's obverse, the long, thick, sweeping tail of the N being particularly prominent. This punch is well known to collectors and it corresponds exactly with that described as Noe I. The reverse XII denominational punch is at the top of the Willow Tree Shilling's reverse and it can be seen very clearly. This punch does not correspond with any other previously known. Like the Willow Tree Shilling's reverse, the New England's reverse is also a new discovery.

Physical Characteristics and Dies of the Discovery Coin

New Willow Tree Shilling: Noe 3-F. Overstruck on a new New England Shilling: Noe I-E.

Weight: 71.8 grains
Diameter: 27.7 mm vertical x 26.3 mm horizontal
Die axis: Coin turn (180 degrees)

The Willow Tree Obverse Die

The die of Noe 3: MASATHVSETS:IN. Small, widely spaced letters, no colon after IN, shoe-shaped root structure, spear point branch at upper right below SA.

Physical description of the obverse side of this coin: MA[S]ATHV[S]ETS IN legible. Tree almost 90% struck up, weak as struck in left center, indistinct at lower right root structure due to puncture. Cross shaped device clearly visible above in branches directly below MA. Inner beaded border missing as struck under [S]AT, missing under second S due to puncture. Outer beaded border visible above THV[S]E only. Breaks in inner beaded border, absence of first and doubling of final S due to strike doubling. Holed through between inner and outer beaded borders at approximately 6:00, the hole pushed through from this side, the coin then turned over and the hole enlarged from the reverse side, showing raised lips of metal around the hole on both sides.

The New Willow Tree Reverse Die

A new die, attributed as Noe F as next in Noe's sequence for Willow Tree Shilling dies. NEWENGLAND:ANDOM. Small and fairly evenly spaced letters in legend, upper stop in colon after first D faint but present, no punctuation after M, small dot inside M. In date, tall and nearly vertical 6, very small 5 with short top, cursive 2. Well spaced and evenly sized letters in denomination, bottoms of the last two seeming to slant upwards to the right. Inner beaded border nicely rounded, left side below first A pinches in to the right.

Physical description of the reverse side of this coin: NEWENGLAND: [AN]DOM. A and bottom half of N in ANDOM faint due to presence of the undertype. Inner beaded border indistinct as struck below NE, missing below [AN] due to the puncture. Denomination and date complete.

Attribution of the New Willow Tree Reverse Die

- This die cannot be Noe A: No colon after M, date letters not evenly sized, 2 not rounded, bases of II in denomination not level.
- This die cannot be Noe B: Spacing between AN DOM close, 52 small, W wide, legend starts at 3:30.
- This die cannot be Noe C: Spacing in NEWENGLAND different, 6 larger, 5 smaller, W wider. The layouts of F and C resemble each other closely otherwise. It is just possible that this die and C were once the same piece of die steel but, if so, this was the earliest state of C, one not seen on any N.3-C.
- This die cannot be Noe D: No colon after M, letters and date numerals small.
- This die cannot be Noe E: No stop after M, letters and date numerals small.

The New England Shilling Host Coin

The Willow Tree Shilling is overstruck on an NE Shilling, obverse over obverse and reverse over reverse. On the obverse of the Willow Tree coin, the New England Shilling undertype's N and its sweeping, thick left and right curves are visible in the branches below NE; left side of NE punch edge faintly visible at left of M. On the Willow Tree Shilling's reverse, the undertype's XII are visible above 65 in the host's date; top, right and bottom right edges of the XII undertype visible in space between [AN] and 65.

The New England Shilling Obverse Punch

The NE undertype's obverse punch corresponds exactly to that already known as Noe I.

The New England Shilling Reverse Punch

The NE undertype's reverse punch is new, attributed as Noe E. It may be described as: XII evenly sized top and bottom, serifs present on bases of II, bases of XII close, II close, punch outline square, with a sharp right angle at lower right as on Noe D.

Attribution of the New New England Shilling Reverse Punch

- This punch cannot be Noe A: Upper left of X not broken, bases of II very close and evenly sized, punch outline square at lower right.
- This punch cannot be Noe B: Bases of XII evenly sized and have serifs, punch outline square at lower right.
- This punch cannot be Noe C: XII close and have serifs, punch outline square at lower right.
- This punch cannot be Noe D: Second I not thicker than first, both evenly sized at bottom and have serifs, X does not touch base of first I.

DISCOVERY OF A NEW U.S. COLONIAL COIN TYPE

by
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and
Mike Ringo; Albany, NY

(TN-188)

Overview

The authors would like to announce the discovery of a major new coin type that properly falls within the U.S. Colonial series. Specifically, two examples of a Georgivs Triumpho obverse muled with a 1767 Danish West Indies XXIIII skilling reverse have recently come to light. Both examples — the authors own one each — were included in an important English collection that was disbursed during the latter 1990s. The Georgivs Triumpho token, in and of itself, has long been regarded as of American relevance; moreover, since the Danish West Indies are now the U.S. Virgin Islands, the colonial relevance to U.S. collectors is in some sense doubled.

Setting the Stage — The Georgivs Triumpho Copper

The obverse of the Georgivs Triumpho copper features a bust right with the legend "GEORGIVS TRIUMPHO" surrounding it. The bust is virtually identical to that used on Irish halfpennies of the 1775-1782 period — both regal and counterfeit issues. The reverse features a central device which appears to be Britannia, in a pose similar to that found on English halfpennies of the period, but in a cage of 13 bars bearing a Fleur-de-Lis at each corner. The legend "VOCE POPOLI" surrounds this design, and "1783" is in exergue.

The general interpretation of the obverse of this copper is that the bust in this instance was used to represent George Washington — and the legend refers to the fact that he triumphed (over England in the Revolutionary War). The reverse represents England defeated (i.e., Britannia shown behind bars) by Washington (as per the obverse) and the thirteen colonies (the bars of the cage) with the help of the French (represented by the Fleur-de-Lis devices); further, the enabler was "The Voice of the People" (the translation of the Italian phrase). The 1783 date corresponds to the end of the Revolutionary War.

The Georgivs Triumpho copper is regarded as having been produced shortly after its indicated date,* most likely circa 1785.[1,5] They must have enjoyed heavy circulation, judging by the difficulty of finding high condition coins. Breen[2], Taxay[3], and other writers state that Georgivs Triumpho coppers appear as undertypes for New Jersey coppers struck in the late 1780s; however, it was not until 1999 that Wierzba published proof of this, providing photographs of a New Jersey 73-aa overstruck on one.[4]

Breen and Taxay, in their cited writings, as well as Vlack[6] and other early researchers, feel strongly, but without conclusive proof, that the Georgivs Triumpho coppers were struck in Birmingham, England.** Ringo[5] shows that these coppers were punch-linked to Nova Constellatio and counterfeit English coppers, and numismatic consensus holds both of these to have been

* Mike Ringo has shown that the Georgivs Triumpho copper is punch linked to the 1783 Crosby 1-A Nova Constellatio copper. Lou Jordan concludes that all 1783 Nova Constellatio coppers were produced during the spring of 1785.

** This is given credence by the similarity in busts on Irish counterfeit halfpence and Georgivs Triumpho coppers. Counterfeit Irish halfpence are known to have been struck in England, and it is likely that the bust device punch used for them was reused here simply as a matter of frugality or expediency.

References are on page 2365.

Figure 1. This figure shows the obverse and reverse of the same Georgivs Triumpho copper. Note the extensive die cracking on the reverse — cracking which caused the reverse die to become unusable before the obverse die. The metrics for this particular coin are: weight 114.2 grains, diameter 28.4 mm, die rotation 170°. [Shown 1.5X actual size.]

Technical Note: If only one diameter is given, it is the x-axis measurement. If two diameter measurements are given, they are the x-axis followed by the y-axis. The die rotation was determined by rotating the coin on its vertical axis and then measuring the reverse die rotation in a clockwise direction.

struck in Birmingham. In counterpoint, Wierzba[4] reports that noted researcher Mike Hodder put forth an argument that the Georgivs Triumpho coppers could have been struck in America.

All researchers agree that, at least to some extent, the Georgivs Triumpho tokens circulated in America. Vlack[6,7] states: "Early research revealed that this token first circulated in Georgia, then in Virginia. Subsequently, as a result of the English bust of George III, many were destroyed or mutilated. The balance were sent to Jamaica for currency. A portion later was discovered used in Florida."

It is believed that both the obverse and reverse dies for this token were placed in service at the same time, with examples known featuring perfect obverse and reverse states (see Figure 1 in the Wierzba article[4] or the illustration of Lot #483 of the auction conducted by the Colonial Coin Collectors Club at its national 2001 convention[8] as examples). A typical example of a Georgivs Triumpho token, from relatively late die states is shown in Figure 1. The reverse die obviously deteriorated faster than the obverse die, and can reasonably be assumed to have become unusable more quickly.

Setting the Stage - Danish West Indies XXIIII Skilling Coins

Danish West Indies XXIIII skilling coins were issued under Christian VII only during the years 1766 and 1767. They were produced by three separate Danish mints (Copenhagen, Altona, and Kongsberg) for export to, and circulation in, the Danish West Indies.[9,10] An example of a typical (several minor die varieties are known) DWI XXIIII skilling of 1767, is given as Figure 2.

Figure 2. This figure shows the obverse and reverse of a genuine *silver* XXIIII skilling of 1767. The obverse dies were shallowly cut. The metrics for this particular coin are: weight 108.6 grains, diameter 26.7 mm, die rotation 0°. [Shown 1.5X actual size.]

A relatively large number of counterfeit DWI XXIIII coins exist. Many were made of copper or brass, and some were lightly silver-plated. The workmanship of these counterfeits is not good, and they often appear quite crude.[10,11] Sømod also notes that these counterfeits originated in England. An example of such a counterfeit, dated 1767, is given as

Figure 3. This figure shows the obverse and reverse of a counterfeit *copper* XXIIII skilling of 1767. The metrics for this particular coin are: weight 94.6 grains, diameter 27.7 mm, die rotation 0°. [Shown 1.5X actual size.] *Photo courtesy Tony Carlotto.*

Figure 4. This figure shows the obverse and reverse of the Martin mule. The metrics for this particular coin are: weight 122.4 grains, diameter 29.2 mm, die rotation 225°. The "holes" that can be seen are natural planchet flaws, and not the result of post-strike damage. [Shown 1.5X actual size.]

Figure 5. This figure shows the obverse and reverse of the Ringo mule. It is double struck and noticeably out-of-round. The metrics for this particular coin are: weight 134.5 grains, diameter approximately 28.7 x 31.0 mm, die rotation about 260°. [Shown 1.5X actual size.] *Photo courtesy Tony Carlotto.*

Figure 3. Though there may have been a number of varieties of counterfeit coins of this date and denomination, the reason the specific example was chosen for Figure 3 will become apparent.

A property of these XXIIII skilling coins, both regal and counterfeit, but belied by Figure 3, is that the obverse dies generally wore out before the reverse ones, likely due to shallow cutting and their positioning in the coining press.

The New Discoveries

Figures 4 and 5 show respectively, the Martin and Ringo specimens of the newly discovered mule — both are struck in copper. Numerous numismatists have examined the coins and overwhelmingly believe them to be Georgivs Triumpho/DWI XXIIII skilling mules struck during the late 18th century. As a "sanity check" the Martin coin was submitted to the American Numismatic Association's Authentication Bureau for an opinion. The formal ANAAB response is:

> We have examined the coin and solicited numerous consultant opinions and have determined it is a contemporary counterfeit.
>
> According to our specialist consultants, characteristics of the design resemble other contemporary counterfeits. As such, our consultants are convinced that this coin was struck from false dies and intended to circulate.[12]

So, we can credibly rule out any latter-day fabrications.

The Ringo coin is technically stronger, but is double struck, making comparative analysis a bit more difficult. The two coins are struck from the same obverse-reverse die pair.

Note that the obverses of both the Martin and Ringo coins are identical to the obverse of the Georgivs Triumpho coin pictured in Figure 1, but in a much later die state. Note the extreme areas of die rust, particularly around the nose and below the letter “M” that can be seen on the mules. Careful analysis of the respective obverses shows that the Martin coin followed the Ringo one in emission sequence.

Now note that the reverses of both the Martin and Ringo coins are from the same die that created the reverse of the counterfeit 1767 DWI XXIIII skilling piece of Figure 3 (now you know why we selected that specific counterfeit as illustrative of the class!). Both are from a later die state than that employed with Figure 3, though the reverse of the Martin coin, as expected, is from an even later die state than the Ringo one, most noticeable by increased central swelling and by the development of a major die crack through the date. Indeed, the Martin reverse seems virtually terminal.

Observations and Conclusion

We can reasonably surmise that (a) the reverse of the Georgivs Triumpho failed and (b) that either the obverse of the DWI XXIIII skilling totally failed or use of its reverse was discontinued, leaving the manufacturer (or perhaps more probably someone who bought scrap material from the manufacturer) with two marginally useable dies. Rather than discarding two acceptable dies, the mules were produced. There was no attempt to silver the coins, so the intent must have been to produce coins that would circulate as coppers equivalent to English halfpennies.

There could not have been many such mules struck, simply because both obverse and reverse dies were already near the end of their useful lives before being pressed into production of these unlikely pieces. Further, the marked deterioration between the Ringo and Martin coins suggests an accelerating failure rate – otherwise, there would surely be more examples extant.

Both examples discovered show evidence of extensive wear, suggesting that these mules actually circulated. Further, their rather crude overall fabric, the poor quality planchet stock, and the lack of quality control argue against their being made specifically for collectors, as was generally the case with improbably muled Condor tokens.

Some other observations are:

- The data presented above clearly supports the theory that the Georgivs Triumpho tokens were made in England.
- DWI coins circulated for a long time, as evidenced by wear on surviving specimens. Extended circulation was necessary as no DWI coins were struck from 1767 until 1816. Thus, a coin issued during the 1780s or even 1790s bearing a date of 1767 would not arouse any particular suspicion. It is even possible that these mules were intentionally struck to appear old — rather like the Canadian Blacksmith tokens of a few decades later.
- Vlack’s association of Georgivs Triumpho tokens with the Caribbean area, coupled with the clearly Caribbean association of the DWI piece, may be entirely coincidental, but allows for interesting conjectures.

And finally, we can conclude that a new coin type has indeed been discovered — a type unquestionably falling within the corpus of U.S. Colonial numismatics (and that of British, Danish, and general Caribbean as well).

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